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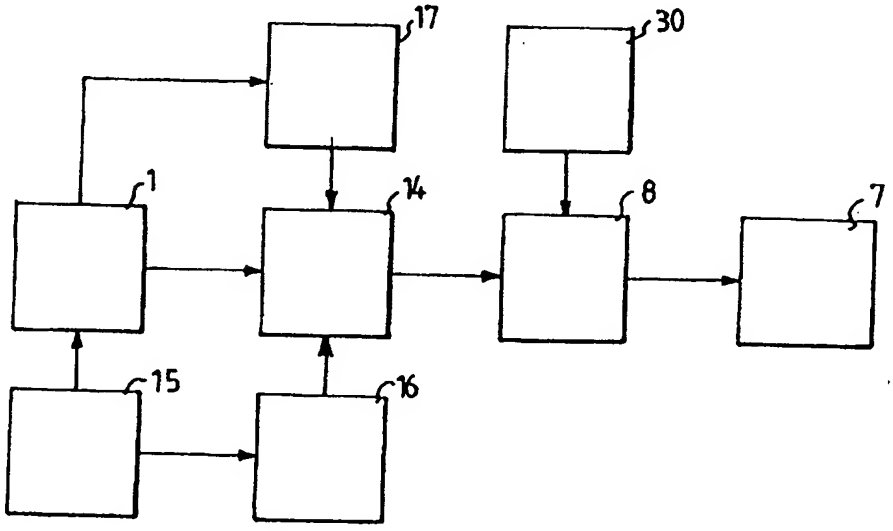


(57) Abstract

Supercharged internal combustion engine (1) comprising an exhaust-driven turbocompressor and a mechanically driven compressor (7), the pressure side of which is connected to the turbocompressor. The mechanical compressor is driven via an electromagnetic clutch (8), which can be engaged and disengaged with the aid of an rpm responsive switch (14), which is arranged to engage the clutch at a predetermined low rpm and disengage the clutch at a predetermined higher rpm. A switch (16) coupled to the engine accelerator (15) breaks the current to the clutch when the driver lifts his foot from the accelerator even if the engine rpm lies in said predetermined interval.

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**Supercharged internal combustion engine**

The present invention relates to a supercharged internal combustion engine comprising an exhaust-driven turbocompressor and a mechanically engine-driven compressor, the pressure side of which is connected to the suction side of the turbocompressor, an engageable and disengageable clutch disposed between the engine and the mechanical compressor and engine speed responsive means which are disposed to keep the clutch engaged within a predetermined engine speed interval.

It is known to compensate the relatively poor charge pressure of a turbocompressor at low rpm with a mechanical compressor which is coupled in series with the turbocompressor in the manner described above. The mechanical compressor is used in various known ways. One known way is to allow the mechanical compressor to be driven permanently by the engine and to use valve means permitting the turbocompressor to suck air directly from the surrounding atmosphere when its air requirement on the suction side exceeds the capacity of the mechanical compressor. The air from the mechanical compressor can then be used for other purposes, for example, it can be conducted, in a known manner, to a charge air cooler to cool the charge air from the turbocompressor. In another known design, said valve means are coordinated with means for controlling a clutch between the engine and the mechanical compressor, said means releasing the clutch when the turbocompressor completely takes over the charging. It is also known to control a mechanical compressor solely as a function of engine speed and to allow the engine to drive the compressor from engine start-up to a maximum rpm, at which the turbocompressor charge pressure is sufficient, as determined by experience, at which time the mechanical compressor clutch is released.

In all of the above described known engine installations, the mechanical compressor will be engaged during operating conditions of the engine where it would be desir-

able to have it disengaged to eliminate the noise generated by the mechanical compressor, noise which cannot be avoided when it is operating and which is louder when the engine is unloaded than when it is loaded. If a vehicle is driven at a speed at which the engine has an rpm at which the mechanical compressor is disengaged and the driver lifts his foot from the accelerator to engine brake, in the last known example described above, the compressor will be engaged when the rpm drops to the above-mentioned upper rpm, e.g. 1500 rpm, and this is regarded by the driver and others as a definite disturbance.

The purpose of the present invention is to achieve a turbo-charged internal combustion engine of the type described by way of introduction, the rpm responsive means for engaging and disengaging the clutch being disposed to keep the clutch disengaged when the engine operating state is such that there is no need for extra supercharging from the mechanical compressor, i.e. during engine braking or when driving at low engine speed and low load.

This is achieved according to the invention by virtue of the fact that said engine speed responsive means cooperate with means which directly or indirectly sense the engine load and block engagement of the clutch when the engine load is less than a predetermined level.

An indirect measure of the load can be obtained from the accelerator position and in a simple embodiment of the invention, the engine accelerator is coordinated with a switch in a current circuit to an electromagnetic clutch. When the driver lifts his foot from the accelerator, for example to engine brake, the switch breaks the current so that the compressor will remain disengaged even when the engine speed drops into the interval within which the compressor is normally engaged when the engine is loaded. In this manner undesirable engagement of the compressor is avoided. When the driver once again wishes to provide more fuel and depresses the accelerator, the

switch will again provide current to the clutch which - if the engine speed is within the above mentioned interval - will engage the compressor.

In a further development of the engine according to the invention, the rpm responsive control means cooperate with temperature-sensitive means disposed to rescind the blocking function of the load-sensitive means when the engine temperature is lower than a predetermined level. By rescinding the blocking function when the engine is cold, the compressor can be kept engaged within its normal rpm range, which provides much more rapid heating up of the engine and thus lower emissions.

The invention will be described in more detail with reference to examples shown in the accompanying drawing, where Fig. 1 shows schematically a four-stroke diesel engine according to the invention, Fig. 2 shows a block diagram of a first embodiment of a control system for the clutch of the mechanical compressor, and Fig. 3 shows a block diagram corresponding to Fig. 2, of a second embodiment.

In Fig. 1, the numeral 1 generally designates an internal combustion engine of diesel type with an intake conduit 2 and an exhaust conduit 3. A turbocompressor consisting of a turbine portion 4 and a compressor portion 5 is disposed, in a conventional manner, in the intake conduit 2 and the exhaust conduit 3. In a conduit 6 branched from the intake conduit 2 there is a mechanically driven compressor 7 with its pressure side communicating with the suction side of the turbocompressor 5. The compressor 7 can be of any known displacement type, e.g. a screw compressor. It is driven directly by the engine crankshaft, for example, via a schematically indicated electromagnetic clutch 8. A check valve 9 is arranged in the branch 10 between the intake conduit 2 and the conduit 6 and, in the example shown, is of the flap valve type. In Fig.1, the numeral 11 indicates an intake air filter, the numeral 12 a charge air cooler and the numeral 13 a muffler.

In Fig. 2, components having counterparts in Fig. 1 have been given the same reference numerals as in Fig. 1.

Engagement and disengagement of the electromagnetic clutch is controlled by a switch 14 in the electrical circuit to the clutch, said switch 14 being actuated by the engine speed and being disposable to close the circuit for engaging the clutch at ca 300 rpm and breaking the current to disengage the clutch at ca 1500 rpm. In the electrical circuit to the electromagnetic clutch 8 there is also a switch 16 coupled to the engine accelerator 15.

The accelerator 15 is spring-biased in a conventional manner towards an idle position and in this position, which the accelerator pedal assumes when it is unloaded, the switch 16 breaks the current to the rpm responsive switch 14 to keep the clutch 8 disengaged, so that the mechanical compressor will not be driven even if the engine speed should lie within the interval given above. This means that the mechanical compressor 7 will not be engaged during motorbraking, for example, when the driver lifts his foot from the accelerator pedal and the rpm drops to within the stated interval where the compressor 7 would have been engaged if the engine were loaded.

The rpm responsive switch 14 is coordinated with an engine temperature sensor 17 in such a manner that the clutch 8 is supplied with current and is turned on even when the switch 16 is turned off, if the engine temperature lies within a predetermined interval. This means that when the engine is cold, the mechanical compressor 8 is engaged at 300 rpm, i.e. as soon as the engine is started, and is kept engaged at idle rpm or slightly thereabove for heating the engine even if the engine is unloaded. This is accomplished not by pressing the accelerator pedal 15 but by adjusting a hand-throttle (not shown) to a low throttle setting. This function provides more rapid warming up of the engine and much lower exhaust emissions than if the

mechanical compressor 7 were kept disengaged. When the engine temperature has reached a predetermined level, the current to the clutch 8 is broken if the engine is unloaded and the switch 16 is in the off-position.

In the embodiment in Fig. 3, the engine 1 has an electronic engine control unit 20, into which signals are fed, representing various engine and vehicle data, such as engine rpm, engine temperature, accelerator pedal position and vehicle speed. From a fuel flowmeter 21 a signal is fed representing the instantaneous fuel consumption, which is a direct measure of the engine load. The basic functioning of the embodiment in Fig. 3 corresponds to that shown in Fig. 2. At a certain predetermined low fuel flow, indicating low engine load, the control unit 20 keeps the clutch 8 disengaged provided the temperature signal from the engine indicates normal operating temperature. When the engine is cold, the temperature signal is given priority over the load signal and the clutch 8 is kept engaged from the rpm where the engine normally ignites (ca 300 rpm) to achieve more rapid heating up of the engine.

If the engine has a so-called exhaust brake (counterpressure in the exhaust pipe or compression brake), the clutch can suitably be provided with a manual control 30, by means of which the clutch 8 can be engaged regardless of whether the engine speed is so low that the accelerator-actuated switch 16 or the control unit 20 breaks the current to the clutch. This control can preferably be coordinated with those operating means which engage and disengage the exhaust brake. By engaging the compressor 7 during exhaust braking, the engine braking power is increased.

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## Claims

1. Supercharged internal combustion engine, comprising an exhaust-driven turbo-compressor and a mechanically engine-driven compressor, the pressure side of which is connected to the suction side of the turbocompressor, an engageable and disengageable clutch disposed between the engine and the mechanical compressor and engine speed responsive means, which are disposed to keep the clutch engaged within a predetermined engine speed interval, **characterized** in that said engine speed responsive means (14;20) cooperate with means (15,16;21) which directly or indirectly sense the engine (1) load and block engagement of the clutch (8) when the engine load is less than a predetermined level.

2. Internal combustion engine according to Claim 1, **characterized** in that the engine speed responsive control means (14;20) cooperate with temperature-sensing means (17) which are disposed to rescind the blocking function of the load-sensing means (15,16;21) when the engine temperature is less than a predetermined level.

3. Internal combustion engine according to Claim 2, **characterized** in that the engine speed responsive control means (14;20) are arranged, when the engine speed is anywhere from zero up to a predetermined engine speed, to keep the clutch (8) disengaged regardless of the engine temperature.

4. Internal combustion engine according to one of Claims 1-3, **characterized** in that the means for load-sensing and blocking engagement of the clutch (8), comprise an accelerator (15) and a switch (16) controlled thereby in a current circuit to an electromagnetic clutch (8), said switch being arranged to break or connect the current in the circuit depending on a certain predetermined actuation of the accelerator (15).

5. Internal combustion engine according to Claim 4, **characterized** in that the accelerator is an accelerator pedal (15) spring-biased towards an idle position, and that the switch (16) is disposed to switch when the accelerator pedal is moved from a depressed position to an idle position.

6. Internal combustion engine according to Claim 1, **characterized** in that the means for sensing the engine load comprise a fuel flow meter (21) which is arranged to provide a signal representing the instantaneous fuel consumption to an electronic engine control unit (20).

7. Internal combustion engine according to Claim 2, **characterized** in that the temperature-sensing means (17) are arranged to provide a signal representing the engine temperature to an electronic engine control unit (20).

8. Internal combustion engine according to one of Claims 1-7 comprising an exhaust brake device, **characterized** in that means (30) are arranged which, when the exhaust brake device is actuated, permit engagement of the clutch (8) regardless of whether the load-sensing means (16,21) indicate that the load is less than said predetermined level.

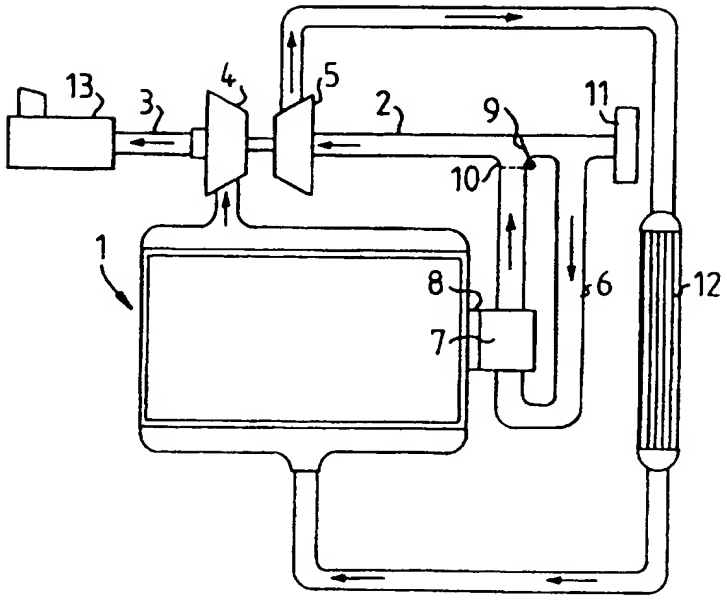


FIG. 1

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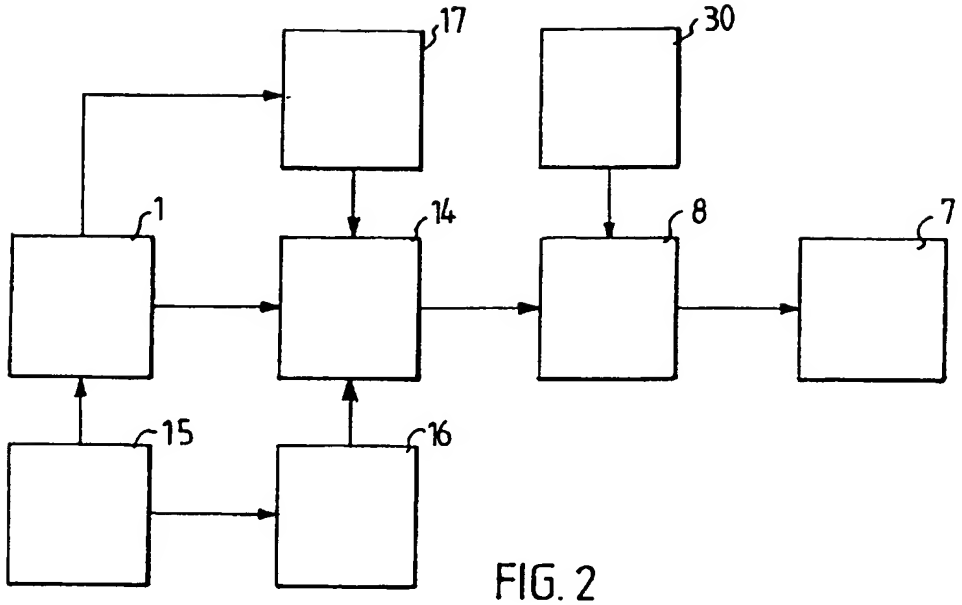


FIG. 2

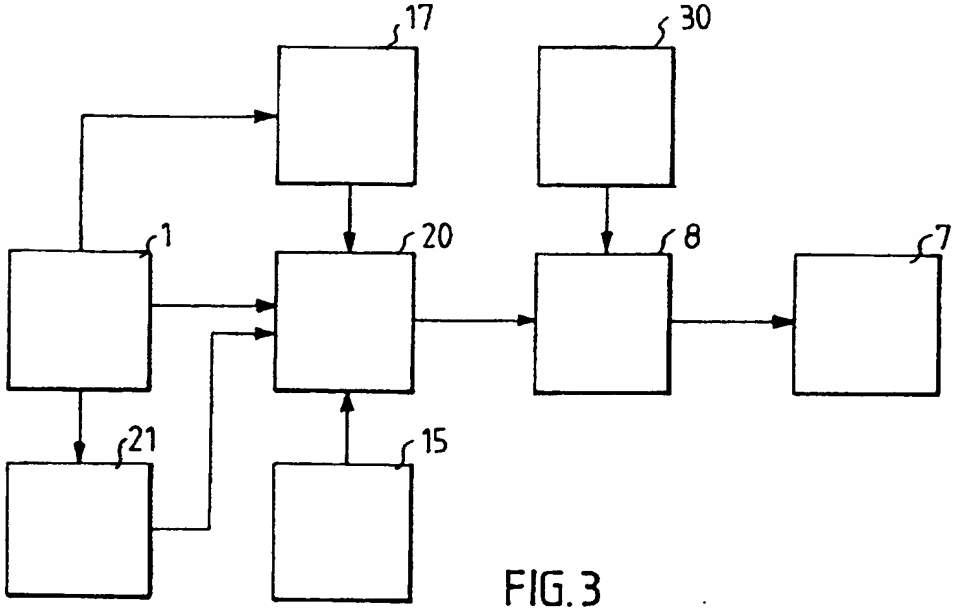


FIG. 3

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/00171

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F02B 37/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

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IPC6: F02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | GB 2182391 A (FUJI JUKOGYO KAISHA), 13 May 1987 (13.05.87), abstract<br>-- | 1-2 |
| X | DE 3636642 C2 (FUJI JUKOGYO K.K.), 24 Sept 1992 (24.09.92), column 2, line 39 - line 64<br>-- | 1-2 |
| X | DE 3710195 C2 (TOYOTA JIDOSHA K.K.), 12 December 1991 (12.12.91) | 1 |
| A | <br>-- | 2-8 |
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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|---|---|---|
| A | Patent Abstracts of Japan, Vol 11,No 368, M-647, abstract of JP,A,62-142824 (TOYOTA MOTOR CORP), 26 June 1987 (26.06.87) -- -------- | 1-8 |

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Information on patent family members

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| | | JP 62111126 A | 22/05/87 |